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PREFATORY NOTE.

THIS little book is intended to familiarise nurses, and students of elementary anatomy and physiology, with the main lines on which the human nervous system is constructed, as well as with the leading principles governing its workings; and to make it particularly useful to the former a few notes explanatory of the more common diseases of the brain and spinal cord have been included. Students who wish to gain a more detailed knowledge of structure or a more thorough knowledge of function in this connexion should refer to the various well-known text-books of anatomy and physiology.

E. L. A.

HARLEY STREET, W.,
Jan., 1915.

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CHAPTER I.

THE CENTRAL NERVOUS SYSTEM.

It is quite clear that without some central board of control, the manifold functions of the body would be in a hopeless state of muddle, and the friction between one part and another would quickly bring the whole human machine to a standstill. All forms of animal life, from the lowest to the highest, are dependent for their existence as living organisms upon powers of adjustment to their external requirements. Consequently, in every branch of the animal kingdom one finds some means of exercising those powers which, although in the simplest animalcules it cannot be dignified by the name of a system, is in more highly developed animals represented by that marvellous network of cells and fibres which we know as the *Nervous System.* It is one of the characteristics of protoplasm—that is, the elementary substance of which all animal cells are formed—that it is responsive (excitable) to outside conditions. Thus, in most elementary types of animal life, in which the whole organism consists but of a single cell, that cell directly responds to external stimuli, such as the presence of food material, and behaves in accordance with the creature's wants. Clearly where the whole animal consists of but one tiny cell or bleb of jelly (protoplasm) there is no need, were there any room indeed, for a nervous system, and it is only when one studies the higher types, consisting first of a mass of cells of the same kind and later of larger and larger masses of cells differentiated into special organs such as the stomach, heart, lungs, and so forth, that one finds an increasingly complicated series of cells themselves differentiated for the special purpose of controlling and keeping up communication between the different parts of the animal body. Of course, the higher one traces development in the animal kingdom, the more complicated does the nervous system become, until in mankind one finds this particular system itself differentiated into a number of parts, each subserving some special function of control or connexion. Thus in ourselves this system is found in its highest state of development, consisting of large nerve centres acting respectively as centres of vital functions, e.g. respiration and circulation, of balance, of movement, and of sensation, the whole controlled by the brain which not only brings together and harmonizes the various functions of the body, but is itself the seat of consciousness and of all mental faculties, such as will, understanding, imagination, attention and so forth. It is, of course, the connecting links between the various nerve centres themselves and the body on the one hand, and with the brain on the other, that are found in the intricate maze of nerve cords that penetrate to every corner of the system. So closely indeed are the central nerve stations connected with the various parts of the body that were the Nervous System alone dissected out and freed from every other tissue it would be found to give an accurate outline picture of the human head, trunk and limbs.

The term *central nervous system* is given for purposes of convenience to those structures—the brain and spinal cord—which are enclosed within the cavity of the skull and spinal bones. On examining a skull which has been cut across vertically it will be found that in front there is a large depression on each side, corresponding to the socket of the eye. This pyramid-shaped hollow is known as the orbit, and above its roof there is a large cavity bounded in front by the bones of the forehead (frontal bones) and communicating behind with the main cavity of the skull which has for its floor the bones roofing in the nose and throat passages; whilst, still further behind, the cranial cavity reaches its lowest boundary and enables the brain to occupy a space extending from the roof of the skull to those bones, the occipital bones, which form its hindmost part. The brain has necessarily to correspond in outline with the cranial cavity and so increases in depth from before backwards as just indicated, thus attaining the peculiar shape indicated by the diagram. At its lowest part—that is, of course, posteriorly —the brain is connected downwards with the spinal cord through the large opening which occurs at the base of the skull known as the *foramen magnum*.

The main mass of the brain is constituted by the *cerebrum* and is very clearly divided into two equal parts by a median division running from before backwards,these two portions being termed left and right *hemispheres*. These are, of course, connected centrally by a strong net work of

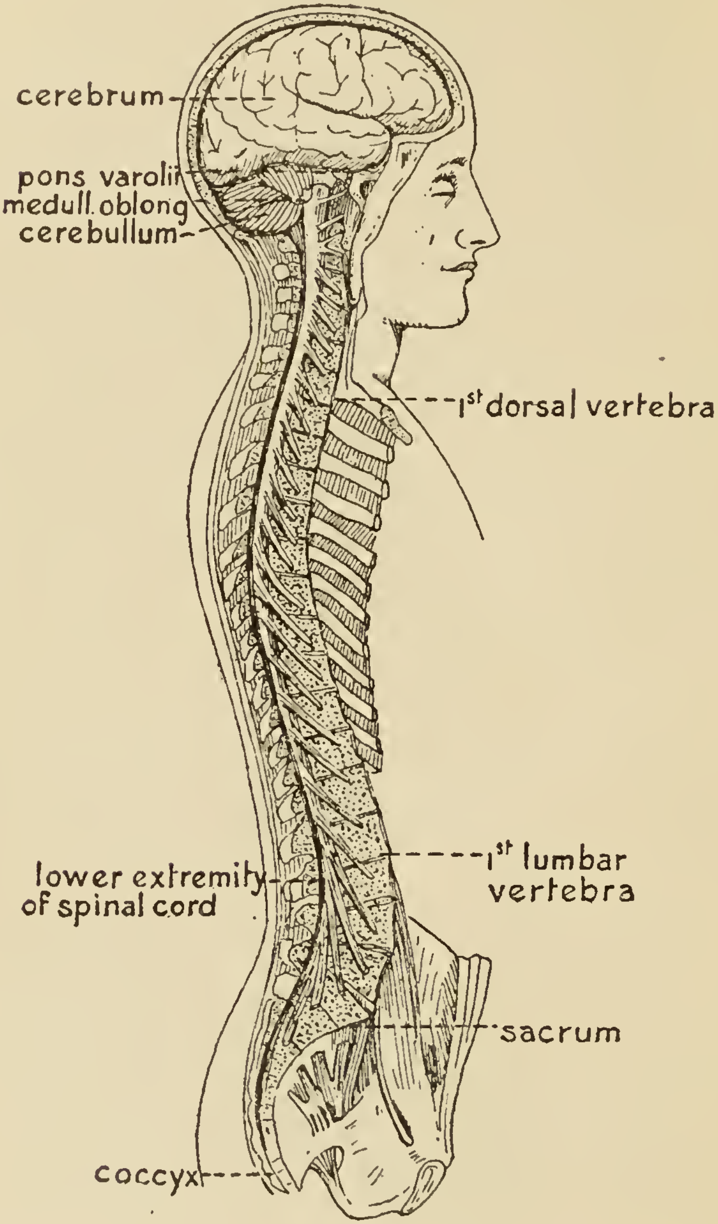

FIG. 1.—Showing general relations of the central nervous system. After Fig. 175 (copyright) in Halliburton's "Handbook of Physiology" (by permission).

nerve fibres—the *corpus callosum*; and are also attached to a lower division known as the *mid-brain*, below which are the *pons varolii* and *medulla oblongata*. The lesser of the two chief portions of the brain is known as the *cerebellum*, and this is also divided into right and left parts. If one places one hand at the extreme back and lower part of the skull, that portion of the brain corresponding thereto will be the cerebellum, immediately above which rests the hindmost portion—the *occipital lobes*—of the cerebrum. The cerebellum is connected to the main brain by three thick strands of nervous tissue, the *cerebellar peduncles*.

Wherever the brain be cut into, it will be found to consist of a pinkish soft mass which is about as firm and consistent as a stiff jelly or blanc-mange. On examining the cut surface, lighter and darker areas will be distinguished, corresponding to the white and grey fibres previously described. It is quite clear that so delicate an organ would suffer very much from shocks and blows to which the head is inevitably liable as well as from the constant alteration of position which the skull is always undergoing, unless there were some special covering to ensure its safety. Thus it is that we find the brain amply protected by three membranes. The first of these, known as the *dura mater*, is a thick, strong, fibrous covering which firmly lines the inside of the skull and acts as a sort of support to which the next layer of covering, the *arachnoid*, of very delicate texture, is attached; whilst closely attached to the immediate surface of the brain is a fine but firm membrane containing many blood-vessels and known as the *pia mater*. Special attention must be directed to the intermediate *sub-arachnoid* space—between the arachnoid and the pia mater—and which, by virtue of the spongy fluid-containing tissue which fills it, serves to absorb and lessen all shocks to the brain. In fact that organ may be considered to be suspended in a semi-fluid bag between the dura mater and pia mater, so that any blow on the skull is softened by the impulse having to pass through this cushion, and likewise any movement of the head only causes the brain to move with less danger within its protective envelope.

All parts of the brain are duplicated, thus providing for the control of the bilateral functions of the body, and, as will be indicated in more detail subsequently, the main portion of the brain—the cerebrum—is divided into two well-marked hemispheres which subserve the control of the two sides of the body. It is this portion of the brain that is the highest of all, and it is only in man that it attains such considerable development. The brains of certain animals, some of the higher monkeys, for example, are very like those of man, but there is an important difference in that in the former the big cerebral hemispheres are wanting. The brain of a child, in which the higher faculties are not yet fully developed, corresponds much more closely to the monkey's brain than does that of the adult, whose far greater cerebral development corresponds to his greater powers of intelligence and mental capacity generally. And as we descend the animal scale it will be found that as mental capacity decreases so there is a diminution of the front part of the brain, until in the lower animals there is practically no cerebrum at all. It is obvious that to maintain the control of the various organs and systems of the body which, as has repeatedly been pointed out, is the main function of the central nervous system it is necessary for the latter to be in close touch with every part. This close contact is effected by means of the long nerve cords which are to be found everywhere by dissection or in the course of operations. Of these nerves by far the greater portion arise from the spinal cord in pairs, further details of their origin being given in a subsequent section. These spinal nerves are those which serve to carry messages from the spinal cord to the muscles for example, on the one hand, and from the skin to the central nervous system, on the other. It will further be demonstrated how the nerve cells of the spinal cord are closely connected by a special system of fibres with the nerve cells of the higher part of the brain ; also how the brain can send messages to the outlying organs, and on the other hand is able to receive messages from the skin and elsewhere.

From the brain itself twelve pairs of nerves are given off, the majority subserving special functions. As would be expected, any direct nervous connexion effected by so important a part of the nervous system as the brain itself must have an exceptionally important significance and it is found that the brain is directly connected with the special senses of sight, hearing, smell, taste and equilibration, all concerning functions which are by far too materially a part in life to be entrusted to the lower levels of the spinal cord.

CHAPTER II.

NERVE CELLS AND NERVE FIBRES.

WHATEVER part of the nervous system is examined it will be found that three kinds of tissue are present: (1) peculiarly shaped cells; (2) long fibres which appear to be like electric wires in that they are covered with a sort of insulated covering; and (3) connective tissue, binding cells and fibres together, and acting as the framework on which the nervous system is built up. This ground-work is termed *neuroglia*. For the most part the nerve cells in the brain and spinal cord are collected into masses known as *nuclei*, but groups of nerve cells are also found in the course of the big nerve trunks which act as telegraph and telephone wires throughout the whole body.

They also exist in connexion with the *sympathetic nervous system*, which particularly controls the automatic functions of digestion, circulation, excretion and so forth, such collections of nerve cells being termed *ganglia*—(single, ganglion).

To understand the various parts played by nerve cells and fibres in the work of the nervous system it is necessary to obtain a thorough understanding of their structure and connexions. Nerve cells are of varied shapes, but for the most part consist of little many-sided bodies of protoplasm containing a conspicuous nucleus. It must be remembered that all animal cells contain a central spot (nucleus), which when treated with coloured solution for the purposes of microscopic examination take the stain more strongly than the general part of the cell body and so appear as distinct dark patches. Such a nerve cell as appears in the diagram may be found in any part of the central axis of the spinal cord, and when seen under a microscope magnified to

Multipolar nerve cell, such as occurs in grey matter of spinal cord.

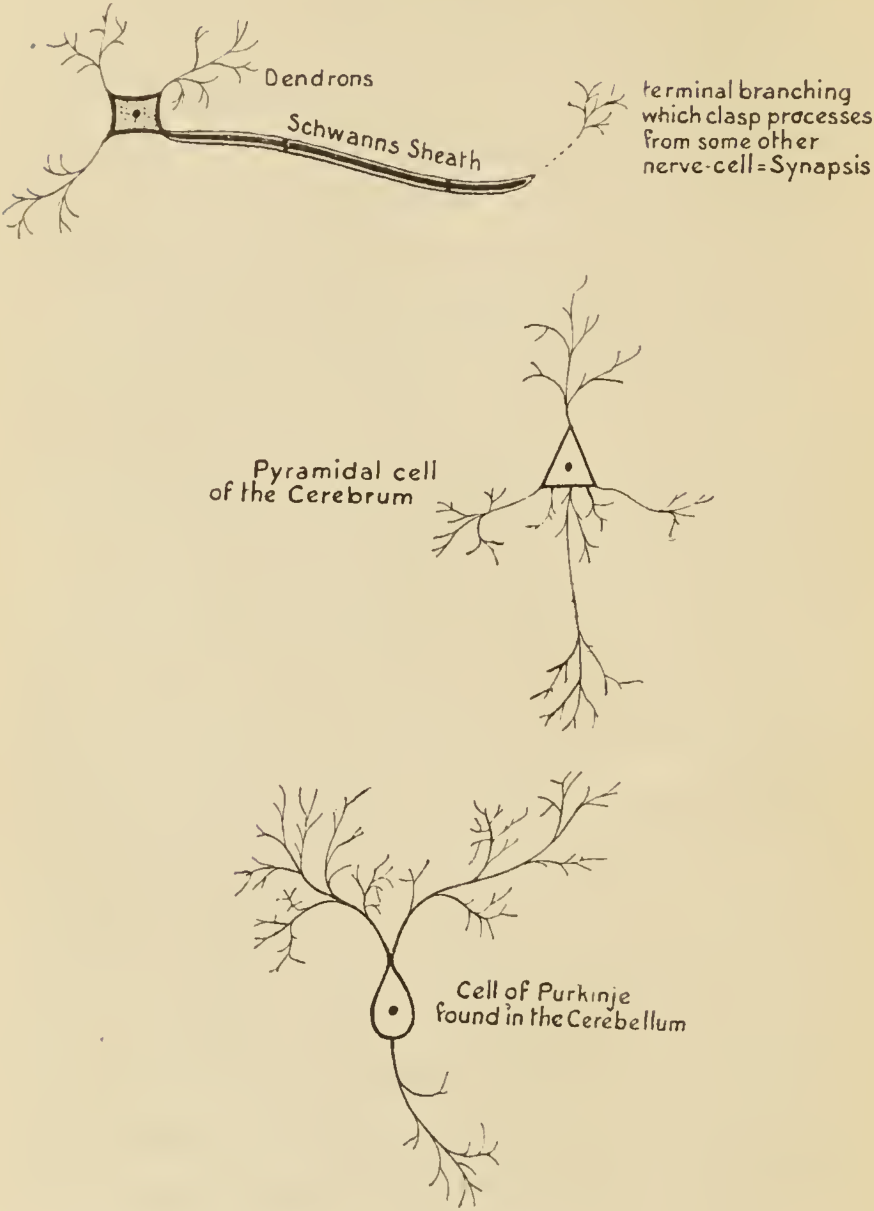
Dendrons
Schwanns Sheath
terminal branching which clasp processes from some other nerve-cell = Synapsis
Pyramidal cell of the Cerebrum
Cell of Purkinje found in the Cerebellum

FIG. 2.—Showing three varieties of nerve cells.

several thousand times its original size appears very much as here shown. Its many-cornered appearance is the first thing that strikes the eye, whilst the dark nucleus is a conspicuous object in the centre of the cell. Again the tree-like projections from several corners cannot fail to escape immediate attention and are remarkable characteristics of most nerve cells. Attention must also be drawn to the fact that at one corner there is no tree-like projection, but, instead, a long wire-like fibre which may be of great length. Lastly it will be noticed that many minute dark-staining bodies are depicted around the nucleus, although they are conspicuous by their absence at the corner from which the long wire (axis-cylinder process) projects. These dark objects are known as *Nissl's granules*, from the name of the discoverer. In reality the branch-like processes extending from the cell corners interlace with corresponding processes from other cells. They are appropriately termed *dendrons*, and undoubtedly serve as a means of communication between one nerve cell and another; the dendritic processes from various cells clasping each other although the tissues themselves are not actually continuous. This interlacing method of contact between two sets of dendrons is known as a *synapsis.*

If one now traces the axis-cylinder process, it will be seen that soon after it leaves the nerve-cell body it acquires a covering which is actually of a fatty nature and to which the name of the *Schwann's sheath* is given. Outside this again is found a covering membrane, the *neurilemma.* Such a projection with its sheath forms a typical nerve fibril such as may be seen in many parts of the nervous system and to which the name of *white fibre* is given to distinguish it from those found in some parts of the sympathetic system which have no white sheath and so appear of a greyish colour, *grey fibre.* Nerve fibres may proceed a long way from their parent cells before terminating, or they may run only a comparatively short distance before coming to an end, and it is very important to note that they end just as do the dendrites in synapses. The nerve fibril commonly gives off side branches at intervals and these likewise terminate in a synapsis somewhere or other. Thus it will be seen that either by its short processes (the dendrons) or by its long process—the *axis-cylinder process*—each nerve cell is brought into close communication in all directions.

Moreover, although it has never been shown by direct experiment how such communication from one cell to another is carried on, it cannot be doubted that the clasping connexions (synapses) formed as indicated are the essential links in every nerve path; and that every impulse, whether it be a message from the brain to a limb giving an order of movement, or whether it be a message of sensation from the skin to any other part of the brain, has to go through numerous cell stations and synapses which represent the various connexions made at different offices when a telegraphic or telephone message is sent from one place to another.

In the central parts of the nervous system, the brain and spinal cord, the white fibres are collected into various bundles which subserve various purposes and which have been clearly marked out by anatomists. Some reference to these will be made subsequently. Similarly for the purpose of transferring messages to and from the outlying parts of the body the numerous bundles of these white fibres are made use of, and it is these bundles which, covered and separated by a thick connective tissue, are found in the arms, legs and other parts of the body as thick *nerve cords* supplying the muscles, skin and various organs. The fibres which are bound up to make these large nerve cords, of which the great sciatic nerve in the back of the thigh is a familiar example, have their origins in nerve cells which are collected in the central part of the spinal cord, from which they emerge at regular intervals along the spine.

Owing to the collection of masses of nerve cells in the central part of the spinal cord and the arrangement of numerous white fibres coming from them, the cord if cut across appears of a dark greyish colour in the centre and of a whitish colour in its outer part. This is because the numerous bundles of white fibres completely surround the nuclei of nerve cells and so present the appearance of a thick white sheath to the central ·axis. In the brain, on the other hand, the nerve cells are collected on the outer surface and send their projecting fibres inwards, so that if the brain be cut across it will be found that the dark part (grey matter) is on the outside, the lighter part (white matter) on the inside. It should be noted that the cells in the outer layer (cortex) of the brain are concerned with the receipt of messages of sensation from the periphery and with the origination of impulses to carry out movement (motor response); they are also as far as can be determined concerned in the appreciation of sensation of all kinds and in the various psychological processes which go to make up the conscious human being. These cortical brain cells have many corners, just as the cells already described, but are of a more pyramidal shape, and the axis-cylinder process emerges from the base of the pyramid itself; it is owing to their shape that the part of the brain cortex in which such cells are found are known as the pyramidal area. The chief motor tract of the central nervous system (pyramidal) which will be described hereafter also derives its name from these cells.

Although constructed alike, the nerve fibres subserve different special functions in the working of the nervous system, and from this point of view may be classified into three main kinds:—

1. *Efferent.*—Conveying impulses from the brain or spinal cord to outlying organs, muscles, skin, glands, and so forth.

2. *Afferent.*—These being the nerves which convey messages from the skin and various organs to the central nervous system.

3. *Inter-connecting.*—Fibres which serve the important functions of communicating together the chief cell stations in the central nervous system itself.

CHAPTER III.

THE CEREBRUM, OR FORE-BRAIN.

To examine the brain it is necessary to open the skull first of all and then to cut through the thick dura mater, which, as already noted, serves as its outer covering. The spongy arachnoid and sub-arachnoid space are then revealed, below which may be seen the true surface of the cerebral hemispheres into which the main part of the brain, the cerebrum, is divided. The two hemispheres are kept apart by a process of dura mater which juts in between them, the *falx cerebri*.

What most strikes the eye on inspecting the exposed cerebral hemispheres is the peculiar convoluted appearance of the surface, which is seen to be marked by innumerable lines, representing little fissures separating countless ridges, the cerebral convolutions. The brain surface

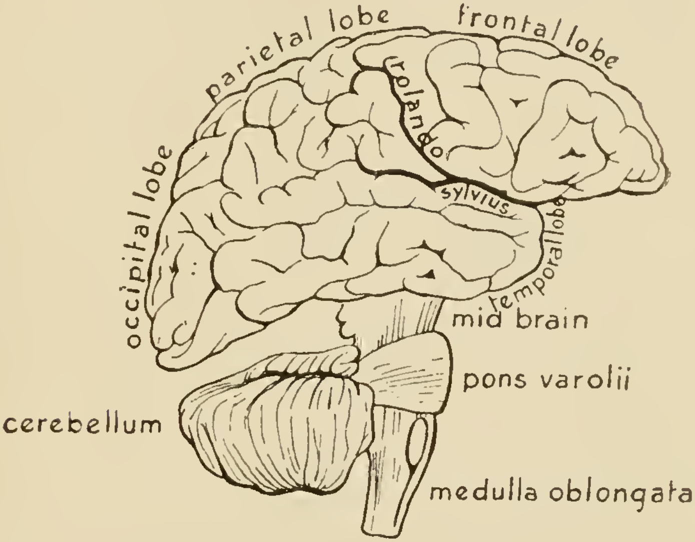

Fig. 3.—Showing main divisions of the brain. After Fig. 396 (copyright) in Halliburton's "Handbook of Physiology" (by permission).

is, as it were, folded in an interminable manner so as to be heaped up into these endless lobes or convolutions. (See Figs. 3 and 4.)

The chief convolutions and fissures of the brain have been mapped out and named according to their position by anatomists, but for present purposes there is no need to enumerate the terms given to various areas. It would be sufficient if the nurse becomes aware of merely two or three of the main divisions. Thus from behind forwards the cerebral hemispheres are mapped into lobes as indicated. The most anterior is appropriately called the *frontal lobe*; the middle the *parietal lobe*, and the most posterior the *occipital lobe*; whilst in front of the latter and below the former lies the *temporal lobe*. It will be seen that this anatomical division is based largely on the position of two main fissures which run in the situation shown. The first of these separates the frontal lobe from that portion of the cerebral hemisphere behind it and is known as the *Fissure of Rolando*. This fissure runs from very nearly the centre of the upper part of the hemisphere downwards and forwards to meet the other main fissure which is known as the *Fissure of Sylvius*. In passing it may be noted that the Fissure of Rolando has a special significance in that the area of the brain closely adjacent to it is specialized for the control of movement and that the various centres (motor centres) controlling the movements of the arms, legs, face, and so forth, are situated thereabout.

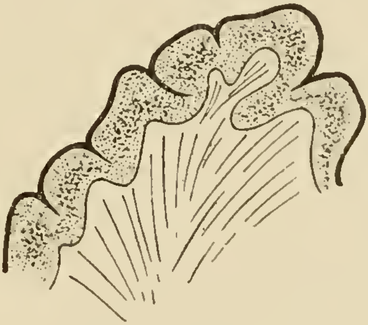

FIG. 4.—Diagram indicating arrangement of white matter and grey matter (dotted) at the surface (cortex) of the cerebrum.

The whole surface of the cerebral hemisphere is covered with a layer of grey matter which as previously indicated consists chiefly of nerve cells; those of a pyramidal form being particularly found in this situation.

So far as can be ascertained it is this grey covering of the cerebrum that subserves all our higher mental functions, and whilst certain areas are particularly devoted to the control of movement, others not yet accurately mapped out are associated with the receipt of messages of sensation of all kinds. The frontal lobes are generally understood to be concerned with our higher intellectual faculties, and injury to this part of the brain commonly leads to great lowering of mental ability. The hindmost part of the brain, the occipital lobe, contains nerve centres for vision in which are received for consideration all messages coming from the eyes. This being so, when either the occipital lobe is damaged by injury or by the growth of a tumour or other pathological condition sight must inevitably become impaired. Those who have had to nurse cases of brain tumour will doubtless remember how a particular form of blindness—*hemianopia*—is one of the chief symptoms where the lesion is situated posteriorly. Again the function of hearing is located in the *temporo-sphenoidal lobe*, a small portion of which, known as the *uncinate gyrus*, is concerned with the sense of smell.

There are many difficulties in finding out the function of each portion of the cerebrum. Certainly experiments on animals have helped largely in localizing special functions, but it must be remembered that the brain of a man is an altogether higher development than that of even the highest animals, and that there are portions, particularly the frontal lobes, which, as already noticed, do not appear to all, or to anything like the same extent, in the brains of the lower organisms. On the other hand, the exercise of a particular function to an exceptional extent is often found associated with special development of a certain area of the brain, and this has given several clues to the special function of various parts. An example of this is to be found in the case of certain sharks and other fishes which depend largely on the knowledge of their surroundings and for their livelihood on the extraordinary specialization of the organs of smell. In these animals the brain is found to consist largely of a certain lobe which is concerned solely with the process of smelling. It is interesting that in man quite a small convolution (uncinate gyrus) is devoted to smell, a circumstance which corresponds to the fact that civilized man depends very little on the use of his nose as a sense organ. On the contrary, a shark is not much of a thinking animal, so has very little cerebrum and certainly no frontal lobe; whilst man is a thinking being and so has a large cerebrum and plenty of frontal lobe. The localization of *motor centres*, that is nerve nuclei the cells of which are concerned with sending out impulses for muscular movement, have partly been found by electrically testing the exposed surface of the brain in monkeys and animals, and partly by noting how tumours or other disease of certain brain areas affect movements. Also by noting that irritating lesions at the brain surface produce muscular movements, the character of the latter corresponding to definite local brain disturbance. Thus a growth or increasing inflammatory deposit in the neighbourhood of the Fissure of Rolando is well known to produce paralysis of face, arm or leg, according to its situation, and in watching a case of this kind it may be noted that the paralysis first starts in one part and gradually spreads to other muscles. When in life paralysis of one arm, for example, has been the chief symptom of an illness and at the post-mortem examination some diseased condition is found corresponding to a certain part of the Rolandic area, and this correspondence is observed not once but in many cases, then the legitimate conclusion may be arrived at that the deep part of the brain disorganized by these tumours has particular association with arm movements.

By careful observations of this kind and the tabulation of innumerable clinical records much progress has been made in definitely locating the centres of muscular movements, which, as has already been stated, are grouped in the neighbourhood of the Rolandic fissure, in the region usually spoken of as the *Rolandic area.* Much work still remains to be done in their more accurate definition. Whilst, however, comparatively little is known as to the exact functions of the different portions of the cerebral grey matter generally, anatomical investigation has established the fact that the different parts of the cerebrum are brought into connexion by countless strands of white fibres, which link up not only one convolution with another but each convolution with other innumerable convolutions, and each group of convolutions with other groups of convolutions. They also, it should be particularly noticed, mutually connect up the cerebral hemispheres, so that the brain, although equally divided into two parts, nevertheless in health always acts as a single organ. The nerve strands performing this marvellous linking-up are designated *association fibres*, the adjective *inter-central* being sometimes added.

CHAPTER IV.

THE CEREBELLUM.

REFERRING to the diagram (Fig. 3) again, it should be noticed that the cerebellum, the hindmost portion of the main brain, is much smaller and of an entirely different appearance to the cerebrum, which, however, it resembles in being divided into two well-marked lobes. These lobes are firmly linked together by a middle lobe, the whole organ being connected through this middle portion with the rest of the brain. Again, whereas the surface of the cerebrum is covered with a host of irregular fissures divided up indefinitely by countless convolutions, the surface of the cerebellum is also divided up into many fine divisions, but in a much more regular manner; the dividing lines running more or less horizontally, as indicated in the diagram, and the fissures being quite superficial. The grey matter and white matter are arranged in much the same way in the cerebellum as in the cerebrum; the nerve cells which maintain its functions being collected into a superficial mass, whilst the white fibres running inwards therefrom constitute the white matter.

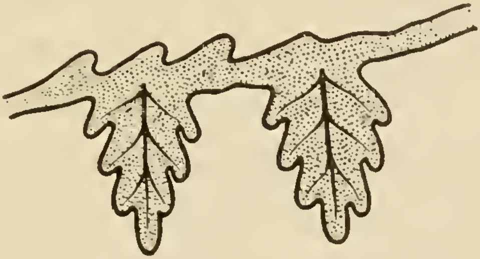

FIG. 5.—Diagram indicating arrangement of white matter and grey matter (dotted) in cerebellum. Note the enfoldment of the latter.

If sections across the surface of the cerebellum be examined with a high-power microscope the cerebellar grey matter will be found to consist of many layers of round and sometimes angular nerve cells sending off their processes and fibres in the usual way, the latter, of course, running down into the white material and serving to take various messages to and from other parts of the brain. Just at the juncture of white and grey matter are to be found a series of remarkable-looking bodies known as the *cells of Purkinje* ; these are flask-shaped and exhibit the peculiar arrangement of processes indicated in Fig. 2.

It is the function of the cerebellum to bring together for harmonious action the various impulses upon which we depend for ascertaining our position in space—that is, to control the important function of *co-ordination.* It is quite evident that without some particular department for looking after and co-ordinating the numerous messages referring to position received from the skin, eyes, internal ear and muscles, no one would be able to walk about or to remain standing. A moment's thought will show that the maintenance of equilibrium must inevitably depend on the true interpretation of such messages as have just been referred to. Thus if one is standing up the messages from the eyes as to one's exact position in space may be enough to give us equilibrium, but knowledge of one's position is completed by the messages that simultaneously come from the soles of the feet, confirming us in the belief that we are standing on firm ground. Then again, we depend very largely for our knowledge of position upon the proper balance of the fluid in the labyrinth of the inner ear, and also on the fact that messages are constantly travelling to the cerebellum from the muscles, giving indication of the position of the latter at any particular moment. It is a very important point to note that we possess a true muscular sense which enables us to judge of the position of the limbs.

Now to carry out the various complicated objects of the body some co-ordinating organ is absolutely necessary, and the cerebellum performs this very important function, for which purpose it is constantly receiving messages of the kind just mentioned. These may be summarized with advantage:—

1. From the eyes.
2. From the surface of the body (skin).
3. From the muscles.
4. From the balancing mechanism of the internal ear.

A physiological experiment that has been performed many times in animals, particularly in birds, is that of removal of the cerebellum. When this is done the bird is unable to fly, but flops about all over the place, showing, moreover, inability to retain its position even when on the ground. Similarly in mankind disease or growth in the cerebellum leads to a condition of extreme giddiness and staggering, so that the patient is in a state of inco-ordination similar to that of a drunkard, this symptom being known as *cerebellar ataxia.*

CHAPTER V.

MID-BRAIN, PONS VAROLII AND MEDULLA OBLONGATA.

A REFERENCE to the diagram shows that at its lowest part the brain narrows very much in preparation for its junction with the spinal cord at the boundaries of the great opening at the back of the skull, the *foramen magnum*, to which attention has already been drawn. This narrow part of the brain—the *medulla oblongata*—situated just below and in front of the cerebellum, is of very great importance, as it is the seat of the vital centres for the control of circulation and respiration. It is connected to the main part of the brain through the medium of the *pons varolii*, which is itself a thick elliptical mass consisting mostly of nerve fibres forming a link between the medulla below and the *mid-brain* above. These three parts, the medulla, pons varolii, and mid-brain, subserve two functions:—

1. For the *conduction of various tracts of white fibres* from the main parts of the brain down to the spinal cord and vice versa; also to and from the cerebellum and cerebrum.

2. As the *point of origin of many important nerves*, the fibres of which proceed from groups of nerve cells—nuclei—in this region.

If one cuts across the medulla it will be found that there is a small lozenge-shaped cavity close to its posterior surface, and roofed in by merely a thin layer of nerve tissue. This cavity is the *fourth ventricle* of the brain and is notable for the fact that in its floor are to be found the masses of nerve cells which form the nuclei for several of the lower cranial nerves. In the mid-brain there is a similar cavity known as the *third ventricle*, and these two cavities are connected through a small canal passing through the pons varolii known as the *central canal*. The third ventricle also communicates anteriorly with a cavity found in each cerebral hemisphere—the *lateral ventricles*.

The fact that the controlling centre for respiration is to be found in the medulla oblongata renders any injury or disease of that part a matter of grave importance. Thus fracture of the spine in the neck, a tumour growing in the upper part of the spinal canal, dislocation of the neck or anything else causing pressure in the neighbourhood of the fourth ventricle, may quickly occasion death. Thus it is that accidents or injuries of the kind indicated affecting the upper part of the neck are invariably fatal. A particular feature of the three parts of the brain now under notice is the fact that through them have to pass the great tracts of fibres which conduct all motor impulses from the brain to the spinal cord and thence to the muscles of the trunk and limbs.

There are, of course, two such tracts, right and left, connected with the right and left cerebral hemispheres, and arising from the pyramidal cells of the Rolandic Area as has been previously indicated. It is indeed owing to the fact that they arise from these particular nerve cells that these conducting paths are generally known as the *pyramidal tracts.* Passing through the mid-brain, and then through the pons, they behave in a singular manner on reaching the medulla oblongata, in that instead of continuing straight down into the right and left portions of the spinal cord on the same side, these pyramidal tracts cross over from side to side, their fibres mingling in an X-like manner. This point is known as the *decussation of the pyramids.* Obviously it follows from this that impulses which start from the right side of the brain and run down through the right mid-brain right side of the pons varolli into the right side of the medulla, eventually find their way into the *left* side of the spinal cord and so into the *left* nerves and the muscles of the *left* arm and leg. Impulses from the *left* side of the brain eventually find their way to the *right* limbs and are responsible for the movements of the *right* arm and *right* leg. Many important practical deductions may be drawn from this. Thus, it necessarily follows that paralysis of the *right* arm or *right* leg indicates injury either on the *right* side of the spinal cord or on the *left* side of the brain, and so where an apoplectic stroke (cerebral hæmorrhage) affects the *left* side of the brain, paralysis will most certainly occur on the *right* side of the body.

CHAPTER VI.

THE SPINAL CORD.

The spinal cord is the downward continuation of the central nervous system contained within the canal formed within the vertebral column (backbone), and necessarily corresponds in shape and extent to that channel, being some seventeen inches long and about half an inch in diameter. The thick outer covering of the brain, the dura mater, is prolonged down so as to line the spinal canal and protect the delicate nerve tissues within. The space between the dura mater and the bony wall of the spinal canal is well padded with loose tissue and fat. Between the spinal cord itself and the dura mater, is an arachnoid membrane corresponding to that described in connexion with the brain, whilst similarly to the latter the surface of the cord itself is closely invested with a thin pia mater containing many blood-vessels just as in the case of the brain. The spinal cord is of course cylindrical, but is somewhat flattened, and towards its lower ends fines down to a point. This lower part is the *conus medullaris*, which terminates in a filament termed the *filum terminale.* The cord itself shows two swellings corresponding respectively with the neck and with the small of the back, that is with the cervical and lumbar regions; it is thicker at these two points owing to the fact that herein are situated the large masses of nerve cells from which the nerve trunks supplying the arms and the lower limbs are derived.

Section across the spinal cord shows that here again two kinds of tissue, namely grey and white matter, are present, the former being innermost and arranged in an X-shaped manner in the centre of the cord. The outlying white matter consists of myriads of white nerve fibres taking their origin from the nerve cells of the grey matter and coursing up and down the cord. They serve as conductors of impulses of all kinds,

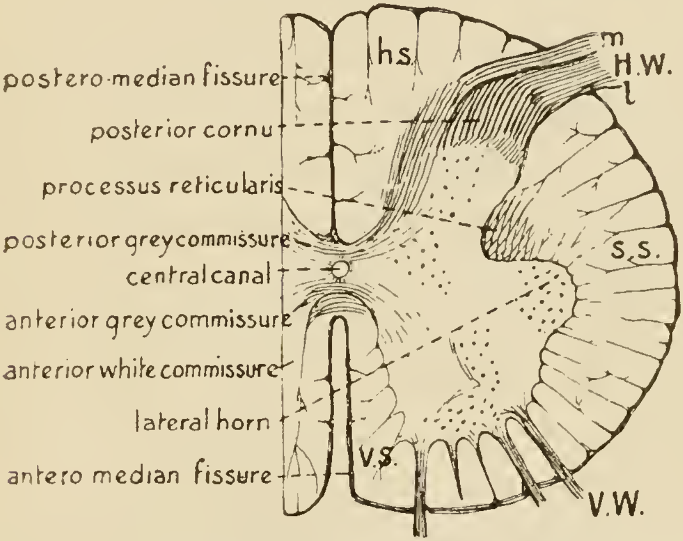

Fig. 6.—Section of the spinal cord. From Cunningham's "Manual of Practical Anatomy" (after Gegenbaur).

both from below upwards and from above downwards.

The spinal cord is the great channel of communication between the brain and the limbs, as well as, of course, to all muscles of the trunk.

Examination of its grey matter under the microscope shows that this consists largely of many-cornered nerve cells similar to those indicated in Fig. 2. The arms of the X-shaped grey matter are spoken of as the *horns* or *cornua* of the spinal cord, anterior and posterior. The *anterior horn* is especially concerned with the sending out of fibres to form cords for the conduction of motor impulses to the muscles; whilst the *posterior horn* is concerned with the receipt of messages of sensation from the surface of the body. The two sets of fibres carrying sensory and motor impulses are conveniently packed together in the main nerve trunks and cords, and it is only when close to the spinal cord that they separate into the two roots. The two divisions of each nerve trunk and its junction with the spinal cord are known as the anterior and the posterior *spinal nerve roots.* A feature of the posterior or sensory nerve root is that it contains a small cell station (ganglion), consisting of nerve cells through which all sensory messages have to pass on their way to the spinal cord. It is a sort of little sub-post-office for messages of sensation on their way from the surface to the spinal cord, and ultimately to the brain.

Throughout its length the spinal cord is indented both in front and behind by two fissures. The *anterior fissure* is quite distinct and cleaves well into the substance of the cord. The *posterior fissure* is evident enough, but it is practically only representative of a membrane or fold of the pia mater. These two fissures divide the spinal cord into two halves which are centrally only bridged together by a little white matter and the mass of grey matter at the centre of the "X," where it indeed surrounds a minute canal passing the whole length of the cord. This central canal communicates above with the central canal of the medulla and through it with the ventricles of the brain.

The spinal cord supplies the trunk and limbs with no less than thirty-one nerves taking origin from each side, with two roots apiece after the fashion already indicated. These nerves are classified into groups corresponding to the spinal vertebræ, and there are respectively :—

Eight Cervical.
Twelve Dorsal.
Eight Lumbar.
Five Sacral.
One Coccygeal.

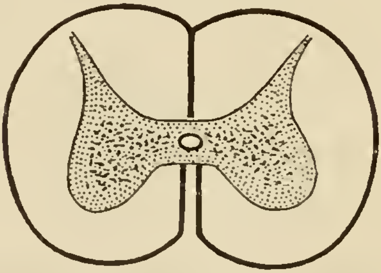

FIG. 7.—Diagram indicating arrangement of white matter and grey matter (dotted) in spinal cord.

These nerves find their way out of the spinal canal by the *inter-vertebral foramina* which are to be seen readily enough on attention to the spinal column of any human skeleton.

CHAPTER VII.

THE MAIN NERVE TRUNKS.

BEFORE considering the manner in which the central nervous system controls the muscles and organs, it is necessary to have some idea of the main communications effected between those parts and the brain or spinal cord. Whilst a number of pairs of *spinal nerves* are distributed to the limbs and trunk, twelve pairs of *cranial nerves* are given off from the brain itself, and as might be expected from the august nature of their origin, are concerned with very important functions, including those of the various special senses. These cranial nerves arise from the base of the brain and are named as follows:—

1. Olfactory.
2. Optic.
3. Oculo-motor.
4. Trochlear.
5. Trigeminal.
6. Abducens.
7. Facial.
8. Auditory.
9. Glosso-pharyngeal.
10. Vagus.
11. Spinal accessory.
12. Hypoglossal.

Considering these in further detail:—

1. *The Olfactory Nerves*, as their name suggests, are concerned with the function of smell, and, arising from the foremost part of the base of the brain send fibres through a small foramen (opening) in the roof of the nose which are distributed to the mucous membrane lining the upper nasal passages.

2. *The Optic Nerves* have vast importance

as being the channels of sight. As white flat strands they are conspicuous objects on the under surface of the brain where they meet together in an X-shaped structure, the *optic chiasma*, before reaching the back of the eyeball; to do which, however, they have to pass through a large opening (foramen) at the back of the orbit. It is to be noted that the optic chiasma is in part a true crossing for some two-thirds of the nerve fibres, by which the optic nerve actually to that extent passes over to the *opposite side* and proceeds to the eye of that side. The result of this is that if any injury or disease affects the optic nerve on one side before it has reached the chiasma there will not result complete blindness of the eye on that side, but part blindness of each side. There are moreover connexions between the nucleus of each optic nerve and the occipital lobe of the brain of the *corresponding side* which is, as already pointed out, concerned with the mental appreciation of vision. It follows from this that injury or disease of the *left* occipital lobe, for example, has a similar effect to that produced by disease or injury to the *left* optic nerve before it has reached the crossing, that is to say, part blindness in *both eyes*. This peculiar condition is known as *hemianopia*.

3. *The Oculo-motor Nerve* supplies all the muscles which are attached to the eyeball, and serve to move it in one direction or another, except two, which are supplied by the *trochlear* or 4th cranial nerve, and the *abducens* (6th) cranial nerve, both of which are small threads. This oculo-motor (3rd cranial) nerve also sends branches to the pupil and controls the small muscle fibres which cause its constriction in response to bright light or near vision.

4. *Trochlear*—see above.

5. *The Trigeminal Nerve* is the chief nerve of face sensation, but also contains some fibres which supply muscles. The sensory fibres of

the trigeminal nerve emerge on the face through three openings :—

a. Just above the orbit, and thus distributed to the skin of the forehead and anterior part of the scalp.

b. Just below the orbit, being distributed to the skin of the cheek and adjacent parts. The same division also supplies nerve branches to the teeth of the upper jaw.

c. An infra-maxillary portion which emerges through a foramen in the lower jaw to supply the skin about the chin and lower part of the face. Before emerging to the face it sends numerous branches to the teeth of the lower jaw.

This Trigeminal (5th cranial) nerve also transmits *sensations of taste* from the front part of the tongue, and controls the movements of the *muscles of mastication*.

6. *Abducens*—see above.

7. *Facial Nerve* sends fibres to the muscles

of the face and so conveys impulses from the brain controlling all movements of expression.

8. *Auditory Nerve* has two important functions:—

a. as the nerve of *hearing*, and

b. as the nerve which collects messages from the *labyrinth of the inner ear*, which as previously mentioned enables us to estimate position in space.

9. *The Glosso-pharyngeal Nerve* is concerned with the collection of impulses of taste from the back of the tongue and also with movements of the pharynx.

10. *The Vagus Nerve*, which as its name suggests, is a wandering nerve, and is the longest of the cranial nerves. It not only has connexions with important structures of the head and neck, including the larynx (voice-box), but continues through the chest into the abdomen, supplying fibres to the covering of the heart

(pericardium), to the pleura covering the lungs, and ultimately to the stomach and intestines.

11. *Spinal Accessory*—this supplies certain important muscles. One of these, the *sterno-mastoid*, is particularly associated with movements of the head from side to side.

12. *The Hypoglossal Nerve* is chiefly concerned with regulating the movements of the tongue.

Spinal Nerves.—The eight pairs of cervical spinal nerves on emerging from the spinal canal mix together and form two networks known as—

1. The *cervical plexus.*
2. The *brachial plexus.*

From the latter several important large nerve cords are given off which run down the upper arm and forearm to the hand supplying nerve fibres to the whole of the skin and muscles of the upper limb.

The chief nerve cords of the upper limb are :—

1. Circumflex, dividing into { *a.* Radial. *b.* Posterior Interosseous.
2. Musculo-spiral.
3. Median.
4. Ulnar.

The *dorsal nerves* go to the muscles of the back and of the trunk, whilst the *lumbar* and *sacral nerves* interlace together forming a network known as the *lumbo-sacral plexus*, from which are conveniently derived numerous nerve trunks, including the great sciatic nerves, which go to the lower limbs.

The chief nerve trunks of the lower limbs are these :—

1. Great Sciatic dividing into { External and Internal popliteal.
2. Small Sciatic.

3. Anterior Tibial }
4. Musculo-cutaneous } branches of External popliteal.
5. Posterior Tibial = continuation of Internal popliteal.

CHAPTER VIII.

CONTROL OF GENERAL FUNCTIONS.

(A)—*Muscular Movement.*

HAVING obtained some general idea of the structure of the central nervous system and the way in which it is connected with the periphery by a series of nerve cords, the nurse will be in a position to proceed to an understanding of the main principles upon which the brain and spinal cord perform their functions of control. The simplest example of this control is to be found in the ordinary muscular movements upon which the well-being of the individual rests in regard to the actions of everyday life.

Our movements have, first of all, to be divided into two chief groups :—

1. *Voluntary Movements*—those which are entirely under the control of the will.

2. *Involuntary Movements*—those which take place independently of the will, and are, indeed, beyond the control of the individual.

At once it may be pointed out that the movements of the heart, as well as of the whole of the alimentary canal (stomach and intestines), and the various ducts within the system are entirely involuntary. Every one knows that it is not possible for us to exert any sort of direct control over the heart's beat or over the movements of the stomach; and, similarly, the great processes of circulation, digestion and excretion, are carried out by movements which are not only quite involuntary, but for the most part outside the ordinary field of consciousness. On the other hand the ordinary acts of daily life are voluntary. Walking, speaking, writing, eating and so forth are all voluntary actions carried out as definite voluntary movements, and even where such actions appear to be habitual, and seem to proceed largely without conscious effort, the impulse setting them in motion is voluntary in the first place.

Reflex Action.—On the other hand it must not be forgotten that many movements of limbs which under ordinary circumstances are voluntary, may under special conditions become involuntary. Thus, whilst a man is absorbed in an interesting book a fly may settle on his hand and he will move the limb without even thinking about it; or again if some part of a sleeping person be lightly touched or pricked, the sleeper will probably make an effort to free himself from the unwelcome stimulus by carrying out movements of which he is quite unconscious. Such actions clearly must be performed through the medium of the nervous system which is able to take control for the time being, when the higher centres of the brain associated with will are not brought into play. Owing to the fact that they represent responses in which a stimulus from some sensory surface is changed into a muscular action, the convenient term *reflex action* is applied to this kind of happening. Now the great seat of reflex action is the spinal cord, and the principles upon which reflexes are carried out may be better demonstrated by a few well-known physiological experiments such as are most commonly carried out with the frog, a cold-blooded animal that is able to survive even after the drastic operation of destroying the brain. If the brain, that is to say the cerebral hemispheres, of the frog are entirely removed *so as to get rid of the organ of voluntary control* the frog will still live, but merely as a machine. It will swim if placed in water or take food which is presented to it, but all such actions are purely automatic and the brainless frog will rest near by ample food supplies without making any attempt to help itself unless such material is actually placed in its mouth. Similarly in water it will swim on and on in an indefinite manner without any attempt to climb out. In the frog the mechanism of the heart's beat, breathing and so forth, can all be perfectly well maintained through reflex action carried on through the medium of the spinal cord.

The brainless frog may also be made use of in the following experiments which more clearly illustrate reflex action than anything so far described. Let such a frog be suspended by its head,—and it should be remembered that having no brain it does not feel pain in spite of appearances,—and a drop of acid, or other irritating substance, be placed on the side of its body, then soon the lower limb of that side will be thrown up to scratch it and remove the source of irritation. The frog will indeed scratch vigorously at the stimulated point. If, however, the lower limb on that side be held firmly, the limb on the opposite side will after a short while be brought into action to bring about relief. These actions are carried out entirely through the medium of the spinal cord in accordance with the numbers expressed in the accompanying diagram. In this S C represents a section through the spinal cord, and M and S represent two cells in the grey matter,

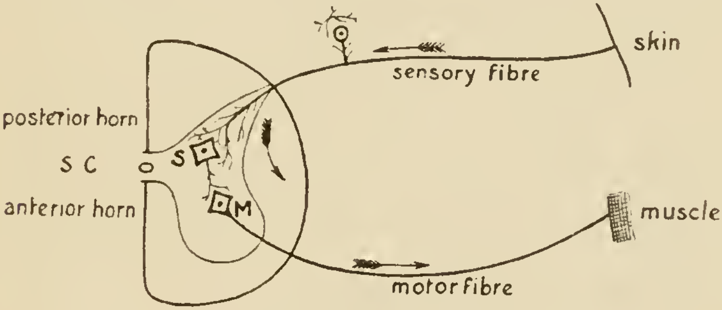

FIG. 8.—Explanatory of reflex arc.

M being the cell connected with the motor nerve fibres (that is those which carry impulses of movement to the muscles), and S connected with the posterior sensory nerve fibres (that is those which convey painful and other sensations from the skin). When the frog's skin is irritated then a message passes up towards S in the direction of the arrow and is conveyed from S to a corresponding motor cell M once an impulse is sent out to the corresponding muscle in obedience to which the latter attracts and carries out the necessary group of movements. So a reflex is carried out through what is known as a *reflex arc*, going through motor and sensory nerve-cell nerve groups on the same side of the cord. Moreover, as it is found that the brainless frog can bring into play the limbs on the opposite side of the body under special circumstances, it is obvious that the reflex arc may include cells on both sides of the spinal cord. To make it quite clear, let it be remembered that it is from the many-cornered motor cells in the anterior horn of the grey matter of the spinal cord that the motor nerve fibres emerge, whilst it is to similar cells in the posterior part of the spinal grey matter that the sensory nerve fibres bring their messages. The primary sensory cell is situated in the ganglion just outside the spinal cord on the nerve root.

It must further be remembered that the connexion between the prolongation of the sensory nerve fibres in the spinal cord, and the cells in the posterior part of the grey matter there, is effected by a synapsis such as has already been described (see Fig. 2); whilst a similar synapsis completes the connexion between the sensory cell on the one hand, and the motor cell on the other.

Voluntary Movement.—A movement is voluntary when muscles move in response to a direct message from the brain. It will be remembered that in the motor part of the brain—Rolandic area (p. 23)—are situated large *pyramidal cells* which send fibres to the *pyramidal tract* which passes through the middle part of the brain into the medulla oblongata where the two sets intermingle and cross over (decussation of the pyramid). Now it is along this pyramidal tract that motor impulses from the brain pass down to the spinal cord. The necessary connexion between the brain and cord is finally effected by the fact that each fibre of the pyramidal tract *terminates at some point in the spinal cord* in a

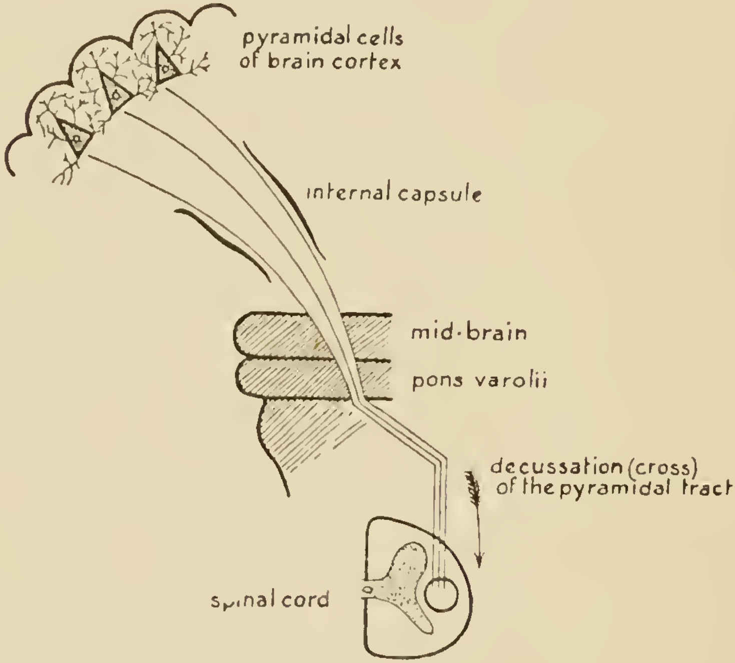

FIG. 9.—Diagram explaining origin and course of the chief motor path, the pyramidal tract.

series of branches which mix with those of a neighbouring nerve cell (motor) in the anterior part of the grey matter of the cord through one of those synapses or junctions with which the reader should now be familiar. Remembering these points, let us now study a simple definite voluntary movement.

A wasp settles on the hand, for example. Here both by sensation and sight the higher centres of the brain are informed of the fact, the messages both of sensation and vision being presented to the brain through—

1. The sensory fibres of the nerves in the arms and hands.

2. The optic nerves.

It is desired to shake the hand to get rid of the wasp and a message is then sent from cells in the Rolandic area controlling arm and hand movements, so that motor impulses are at once sent out along the pyramidal tract down to the spinal cord. These impulses—orders to arm and hand muscles—pass over the telegraphic exchange constituted by the synapsis between the pyramidal fibres and the spinal cord nerve cells and then pass out along the nerves of the arm and hand, proceeding to just those muscles which it is required to move. Let it be particularly borne in mind that if the hand in question is the *right* hand then the motor cells in the *left* cerebral hemisphere are those which initiate action, because, as has been already pointed out, there is a crossing in the lower part of the brain (medulla) to the effect that each hemisphere of the brain controls the muscles upon the *opposite side of the body* (see p. 66).

CHAPTER IX.

CONTROL OF GENERAL FUNCTIONS.

(B)—*Sympathetic Nervous System.*

In addition to the central nervous system with its various connexions, there is an auxiliary system of nervous control which is concerned with the numerous bodily functions, such as the movements of the stomach and intestines, alterations of the calibre of the blood-vessels, the beat of the heart, and all other processes which are involuntary in action. That is to say, it controls those mechanisms which go on automatically day by day without our having to exert voluntary control over them. This subsidiary organization is the *sympathetic nervous system* and is constituted as follows :—

1. Its main portion consists of a series of nerve-cell stations—*the sympathetic ganglia*—situated in two rows, one on each side and in front of the spinal column. These ganglia are linked up by chains of nerve fibres and are also connected with the central nervous system (spinal cord) by special nerve filaments termed *rami communicantes.*

2. Masses of nerve cells forming large sympathetic ganglia in the *abdominal cavity*, interconnected by a remarkable network of grey nerve fibres. One of the largest of these masses is the *solar plexus* which is connected with many important organs, including the stomach, intestines, and kidneys. It influences changes in the blood supply, and therefore the working of those organs. It may be noted that the full extent of the control which the solar plexus exerts over the abdominal organs and of its importance in the workings of the human machine is not yet fully understood.

3. Collections of sympathetic nerve cells actually *in the walls of various organs*, also forming plexuses therein. Important sympathetic connexions of this kind exist in the heart and in the intestinal wall.

The part which the sympathetic nervous system plays in life is indicated by the term *autonomic* which is commonly given to it nowadays. That is to say, it possesses a certain ability of self-government and is able to act to some extent on behalf of the central nervous system. It is to be noted that the nervous impulses which control the various bodily functions in the first place arise within the brain or spinal cord and thence travel to one or other of the great sympathetic ganglia, thence to be distributed according to requirements. It is in this distributing process that the plexuses play their chief part.

Heart and Circulation.—The mere fact that the beat of the heart may be rapidly increased by a variety of causes external to itself, as, for example, the receipt of bad news or an indigestible meal, shows that that organ is connected with the central nervous system, and through it indirectly with other parts of the body. Indeed palpitation thus caused is an obvious indication that the heart is influenced or controlled by processes going on in the nervous tissues elsewhere. The nervous mechanism of the heart's beat is one of the most complicated problems of physiology, the details of which would require for their description a whole book many times the size of this little work, but that is no reason why nurses should not comprehend the chief factors in its control, to which end it is sufficient to realize that the nervous control of the heart acts in two ways:—

1. *Acceleratory*—that is, tending to *increase* its beat in force and frequency, and

2. *Inhibitory*—that is, tending to *diminish* its rapidity of action.

Experiment has shown that the inhibitory (stopping) nerve impulses are conveyed in the branches which the heart receives from the tenth cranial nerve (vagus), whilst the accelerator impulses are carried to it by nerve fibres proceeding from the sympathetic nervous system. In this constant balance of control from without, in which a mean has to be established between orders for beating slowly and orders for beating more quickly, little ganglia (collections of sympathetic nerve cells) in the wall of the heart itself play a very important part. Moreover it is important to know that the heart's beat depends to some extent on the freedom of the circulation in the outer parts of the body. Now, the wider the calibre of the myriads of blood-vessels in the peripheral parts of the body, the less must be the actual pressure of the blood in those blood-vessels, and consequently the less work the heart has to do in pumping the blood around the body. By means of sympathetic nerve fibres distributed in the walls of the arteries and controlling their muscular coats the body has a remarkable means of increasing or diminishing the quantity of blood going through various parts of the system. Such nerves are known as *vaso-motor nerves* and are either *constrictor* or *dilator* in function. That is to say, the blood-vessels are dependent on two sets of impulses from the central nervous system, one of which leads to their narrowing (constriction), the other to their widening, or dilation. The vaso-motor nerves are continually in action in one way or another serving to maintain a proper flow of blood to different organs, as well as a sufficient pressure in the circulation generally, and exerting constantly an indirect influence on the heart itself. An important part of the control of the cardio-motor and vaso-motor nerves is exerted by a collection of nerve cells, *the vaso-motor centre*, in the lower part of the brain, the medulla oblongata. A consequence of this is that any injury to this region necessarily causes such a disturbance of the regulating function that the circulation fails with fatal consequences.

Respiration.—The function of respiration is controlled by a collection of nerve cells known as the *respiratory centre*, also situated in the medulla oblongata (floor of the fourth ventricle, close by the centre for the control of circulation), a circumstance which further adds to the dangers of injury to this region. Any accident in which the neck is broken, or other happening by which pressure is brought to bear on this part of the spinal axis, causes respiration to cease and circulation to fail. This is the reason why injuries of this kind are so immediately fatal.

The function of respiration is maintained by the stimulation of the nerve endings of the respiratory nerves in the lungs. This stimulation depends on the chemical composition of the air in the lungs at any particular moment. When the air therein is impure the spinal centre sends out the necessary messages for the contraction of muscles to expand the chest and draw in fresh air. When this has been done the chest is allowed to contract again and impure air is expelled.

Other Bodily Functions.—In the same way by a reflex mechanism in which afferent fibres convey messages to the central nervous system giving information of local conditions and requirements, whilst efferent nerve fibres convey the commands of the nervous system for the adjustment of organs so as to meet those local conditions, practically the whole of the bodily functions are carried on. Thus the presence of food in the mouth excites a flow of saliva to deal with it, whilst the presence of food substances undergoing digestion in the intestinal tract causes a contraction of involuntary muscles to drive it on from one point to another. Again by the efficient play of the vaso-motor nerves a greater or less quantity of blood is driven through the kidneys every minute, and the waste products thereby extracted from the system at a rate corresponding to its necessities.

Yet, again, when the body is over-heated the reflex mechanism of heat-regulation is brought into action so that by messages sent along the vaso-motor nerves the blood-vessels of the skin dilate and the surface becomes flushed with blood which is thereby exposed to a cooling process. Whilst more important still in this connexion messages are sent to the sweat-glands by which profuse perspiration occurs, and the resulting evaporation of a considerable quantity of fluid from the surface of the body necessarily greatly aids the cooling process. On the other hand when the body is cold, the vaso-motor impulses cause a paling of the skin, with constriction of the blood-vessels, whilst inhibitory (stopping) impulses are sent to the sweat-glands to reduce their activity at such a time.

CHAPTER X.

MANIFESTATIONS OF NERVOUS DISEASE.

As has been previously pointed out, a great deal of our knowledge of the functions and method of working of the nervous system has been derived from a study of diseased states, and in course of time it has been found possible to devise schemes of examination and tests by means of which the disturbed conditions of the nervous system may be revealed clinically. It is not to be expected, nor is it desirable, that nurses should take upon themselves the duties of diagnosis, but at the same time it is very helpful to every nurse who has to deal with nervous diseases that she should have some elementary knowledge of the meaning of the various tests and methods used by the neurologist in dealing with patients suffering in this way.

Every systematic examination for nervous disorder should include the following points:—

1. *Condition of the Cranial Nerves.*—By testing the special senses of smell, sight, and hearing, respectively controlled by the 1st, 2nd, and 8th cranial nerves, diseases affecting those nerves, or that part of the central nervous system from which they arise, may be detected. Again, irregular movements of the eye occasioning strabismus (squinting), or dropping of the eyelid (ptosis), reveal trouble concerning the ocular-motor nerves. Reference to the section on Cranial Nerves (p. 52) recalls to mind that these nerves are the 3rd, 4th, and 6th; whilst the same table shows the functions which are likely to be deranged in disorders affecting the various other cranial nerves either in their course or at their point of origin in the brain. Thus paralysis of the muscles of mastication and loss

of taste on the anterior two-thirds of the tongue, indicates a lesion of the 5th nerve, irritation in the course of which may also give rise to agonizing neuralgic pains in the face or jaws as it is one of the functions of this large nerve to supply sensory fibres to the face and teeth. Action of the chief muscles of mastication may be ascertained by the simple procedure of placing one's hand on the outside of the patient's jaw and telling him to bite, when in health the contraction will be readily felt.

Facial Paralysis, that is inability to use the muscles of expression, similarly indicates trouble along the course of the 7th or facial nerve, whilst diseases affecting the 9th and 10th cranial nerves will be evidenced by *difficulties of swallowing*, inability to move the soft palate, and, in the case of the vagus (10th), sometimes by hoarseness or loss of voice, indicating paralysis of laryngeal muscles.

The Spinal Accessory Nerve, or 11th cranial nerve, supplies certain muscles which are used in the action of turning the head round, and so disease or injury of this nerve causes difficulty in such movements. Anything of the nature of a growth or inflamed gland which may act as an irritant to the spinal accessory nerve in its course through the neck may cause violent muscular contractions of the muscles in question, with the result that the head is spasmodically turned to one side, a condition known as *torticollis* or *wry neck.*

Again, if a patient is told to put his tongue out and it is protruded to one side in spite of all he can do to keep it straight, then it is obvious that there is paralysis of the tongue muscles on one side and some condition interfering with the function of the 12th cranial (hypoglossal) nerve may be suspected.

2. *Reaction of the Pupils.*—Under normal circumstances the pupil of the eye quickly reacts to variations of light, contracting in bright day-

light or artificial light, and expanding in darkness, so as to admit or exclude light from the eye according to requirements. A less known reaction is the contraction of the pupil on visual accommodation. That is to say, if a person is told to gaze into the distance and then to look at a near point it will be found that the pupil *contracts* on so doing. Failure of the pupil to react to light is a most serious sign and in the absence of local eye disease, *invariably indicates a serious nervous disease.* The term *Argyll-Robertson pupil* is not infrequently given to a condition in which the pupil is contracted and fails to respond to light or darkness. Unequal size of the pupils as well as irregularity of outline are also noted by the physician in going through his scheme of nervous diagnosis.

3. *Motor Signs.*—Weakness or paralysis of trunk and limb muscles occurs constantly in various nervous diseases and may readily be ascertained by such simple tests as telling pa-

tients to clasp one's hand, to draw back the arm against pressure, or to make active movements with the lower limbs.

Tremor is also a common motor manifestation of nervous disease. A great many different kinds of tremor have been described and experts are fully aware of the significance of these variations. One particular variety may now be mentioned, that known as an *intention tremor*—in which the trembling becomes more violent when an attempt is made to use the affected part.

4. *Sensory disturbances* also not infrequently reveal the presence of nervous disease and may be of two kinds :—

A. *Anæsthesia* or *analgesia ;* that is complete insensitivity or dulled sensitiveness to pain, respectively.

B. *Hyperæsthesia ;* that is abnormally acute perception, so that a light stroke on the surface may be quite painful.

These alternations of normal sensitiveness are rapidly detected by simple methods such as tapping with the finger, stroking the skin, or testing with the head and point of a pin. More accurate estimations are made by an instrument known as an æsthesiometer.

5. *Co-ordination.*—Reference to the section on the cerebellum will recall the important part played by the function of co-ordination in our daily life and comfort. Failure of proper co-ordination is a serious sign of nervous disorder and may be revealed by such things as the following:—

1. Inability to pick up a pin with ease.
2. Inability to touch a given point swiftly and accurately with one finger.
3. Giddiness on standing or walking, particularly giddiness when standing up with the eyes closed.
4. Staggering gait just as in drunkenness, where inco-ordination due to alcoholic poisoning is responsible for many of the

more obvious signs, including thickness of speech.

Romberg's Sign is manifested when a patient on being told to stand up with the feet close together and the eyes closed, sways from one side to another, thus evidencing failure of co-ordination.

6. *Reflexes.*—There are certain muscular responses technically known as reflexes which must be familiar to all nurses who have had to deal with medical work, and which are of importance in the diagnosis of nervous disease. Of these—

The Knee-jerk is, of course, the best known. On asking the patient to sit with his hands crossed, then tapping the upper limb slightly just below the knee-cap, a sudden jerk forward of the leg is invariably obtained in health. In disease this jerky response or reflex may be either exaggerated or absent. The former may or may not be of serious significance; the latter always indicates grave disturbance of the spinal cord functions.

The Ankle-jerk and *Elbow-jerk* are similar responses which may be obtained by tapping the heel tendon and the tendons just above the back of the elbow respectively.

Other points which must be attended to in the diagnosis of nervous disease include the *estimation of mental faculties*, memory, attention, understanding and so forth as well as the question of *disturbance of nutrition.* In some nervous troubles there is a definite failure of nutrition owing to disorder of nerves supplying certain parts. Under some circumstances this failure may be so grave that a deep perforating ulcer may occur at a point where there is constant pressure, such as the ball of the great toe, and its presence is always of serious significance. Such conditions are termed *trophic.*

CHAPTER XI.

COMMON NERVOUS DISEASES.

Nurses will find it useful to have some knowledge of the chief manifestations of the more common nervous diseases, both organic and functional, with some understanding of the underlying sources of mischief, and for this purpose the following brief notes thereon will not be out of place.

One of the first things that will be noticed in connexion with the question of nervous disease will be the interest of the medical attendant as to whether any particular condition is *functional* or *organic*, and it is very important that the significance of these terms should be clearly understood. Preceding sections have demonstrated that the nervous system is made up of many complicated structures, which have very delicate functions, and just as it is possible for a machine or a clock, for example, to work improperly without there being in it serious structural defect, so it happens that the nervous system not infrequently functions abnormally without the physician being able to detect any definite alteration of structure. Consequently it is convenient to divide nervous diseases into two groups:—

1. Those in which the illness is due to some *gross abnormality*, such as inflammation, degeneration of tissue, new growth or other cause of pressure,—that is, in which organic (structural) changes are present.

2. Those in which the disturbance is *functional only*, that is to say, in which there is no evidence of damage or injury to the physical nervous system itself.

ORGANIC BRAIN DISEASES.

In the medical wards of any general hospital one of the commonest kinds of nervous disease met with is that in which there has been some disturbance affecting the blood-vessels of the brain, to the end that failure of nutrition has occurred in one or other part of the cerebrum, with or without increased pressure within the skull. Such vascular disease is commonly one of three kinds :—

1. Cerebral hæmorrhage.
2. Cerebral thrombosis.
3. Cerebral embolism.

Cerebral hæmorrhage is due to the bursting of a blood-vessel in the brain as a result of which not only is the blood supply cut off, but the outflow produces a large clot and consequently great pressure within the brain substance. Such a bursting commonly occurs in elderly people and results in a sudden attack of unconsciousness, the patient unexpectedly falling to the ground in what is known as a fit of *apoplexy.* Moreover, as the blood-vessels which generally suffer in this way are those supplying the motor portions of the brain (Rolandic area, see p. 23), it follows that even when consciousness is recovered paralysis remains. The resulting impairment of movement commonly affects the whole of one side. The grave nature of this condition is obvious enough that it is not surprising that, even if the first attack be not fatal, subsequent ones may quickly end life.

Cerebral thrombosis is a condition in which owing to disease of the brain arteries a clotting of the blood occurs therein, and so stops the circulation passing that particular point. The result is that unconsciousness sooner or later occurs and paralysis of greater or less extent, according to the actual situation of the affected part. Thrombosis of the brain is by no means as common as cerebral hæmorrhage.

Cerebral embolism is due to the sudden plugging of a brain artery with a clot which happens to be travelling in the circulation and commonly derived from some diseased condition of the heart. The plugging occurs suddenly, so that as with hæmorrhage there is a dramatic termination of active life, the victim being suddenly arrested in the midst of whatever he happens to be doing and becoming unconscious. As this plugging, similarly to hæmorrhage, commonly occurs in one of the arteries supplying the Rolandic area, paralysis usually follows.

Intra-cranial tumours.—The presence of a new growth in the brain, either cancerous or innocent, naturally occasions gradually increasing pressure within the cranial cavity. It is obvious that there is only a limited space within the skull and that this is entirely filled by the brain and its immediately adjacent structures. So that if a cancer, for example, grows in the brain, abnormal pressure sooner or later must be noted therein. Similarly an acute inflammation, particularly when leading to formation of an abscess or the growth of a tuberculosis mass, may lead to increased pressure. Thus it happens that, in the first instance, the signs of any inflammatory disease occasioning a mass of new tissue or fluid swelling within the brain will be much the same. The three chief signs of such increased pressure are:—

Very severe headache.

Repeated vomiting, independently of meals.

Inflammation of the optic nerves (*optic neuritis*).

Disturbance of the functions of one or other of the cranial nerves according to the site of the pressure.

Meningitis is the term given to inflammation of the covering membranes of the brain, the pia mater being most commonly affected. Such disease depends on infection by some kind of microbe which may either gain access through the blood-stream, or in some cases through local bone disease, such as that attacking the inner ear. Where meningitis gives rise to pressure it will also result in the signs just referred to, in addition to which there will be, of course, high temperature, rapid pulse and other signs of inflammatory mischief.

ORGANIC SPINAL CORD DISEASES.

Organic diseases of the spinal cord produce disturbances of the sensory and motor functions dependent on the exact situation of the nervous lesion. Growths and inflammation may affect the spinal cord, just as they affect the brain, occasioning paralysis and other disturbances which necessarily vary greatly. There are, however, two spinal cord diseases which are more commonly met with than others. Of these—

Locomotor ataxia is due to degenerative processes which damage certain posterior parts of the cord so that they can no longer take messages of sensation to the brain. As a result of this the patient loses the advantage of messages from the soles of the feet and, feeling as if he is standing on cotton-wool, loses touch with the earth as it were, and suffers all the inconvenience of inco-ordination. A state of things which is manifested by the fact that when he closes his eyes he loses the sense of position in space and tends to fall. Romberg's sign (see p. 85) is therefore always readily elicited in well-marked cases of locomotor ataxia. This want of co-ordinating power also accounts for the stamping gait and staggering characteristic of the illness.

Other signs of this disease are absence of knee-jerks, the Argyll-Robertson pupil, and "lightning pains" shooting about the back and limbs. A particularly distressing feature of the illness may be atrophy of the optic nerves with resulting blindness. Locomotor ataxia is also termed *tabes dorsalis.*

Disseminated Sclerosis is due to the degeneration of certain of the motor tracks in the spinal cord and is characterized by—

Exaggeration of the knee-jerks and other reflexes.

Intention tremor.

Stiff dragging gait so that the feet are invariably scraped along the ground in walking.

Nystagmus, that is a peculiar fluttering movement of the eyes when the patient is asked to follow a moving point with his gaze.

Myelitis is an inflammatory condition of the spinal cord which may either be acute or chronic. The latter form is responsible for a good deal of paralysis affecting the lower limbs, such as is found in infirmaries and institutions for the incurable. Its chief manifestations are due, of course, to the cutting off of the passages of communication between the periphery and the brain as well as to the complete destruction of the cells and fibres of the spinal cord.

It is important to note that in all spinal cord troubles there is a defect of the vesical and rectal sphincter muscles sooner or later, with the result that in any chronic disease of this kind want of control over the ordinary natural functions is likely to be one of the most distressing features.

Neuritis is a common inflammatory condition of the main nerve trunks due to rheumatic, gouty, or toxic factors. In the early stages it is manifested by disturbances of sensation leading to acute sensitiveness with numbness and tingling of the limbs, and particularly of the hands and feet; also of increasing loss of power in the muscles supplied by the nerves affected. Neuritis is one of the most painful and chronic nervous diseases that the nurse has commonly to deal with.

FUNCTIONAL NERVOUS DISEASES.

Common functional nervous disorders include :—

Paralysis Agitans—characterized by a peculiar shaking of the whole body, with nodding movements of the head, and so-called "pill-rolling" movements of the fingers and thumbs.

Increasing stiffness of the muscles.

Want of control of forward and backward movements, so that if the patient should fall forward ever so slightly he continues walking rapidly until he stops or falls.

Rigidity of the face muscles, with the result that the expression becomes fixed and mask-like.

Epilepsy—characterized by convulsive attacks, preceded by a warning sensation or aura and a loud cry; also accompanied by unconsciousness and followed by exhaustion and headache.

Neurasthenia—a condition of nervous exhaustion brought about by worry, over-work or some poisoning of the system and manifested by a great variety of symptoms.[1]

[1] See footnote on next page.

Hysteria—in which are manifested definite physical signs affecting the motor and sensory systems.[1]

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[1] A detailed account of neurasthenia (with psychasthenia) and hysteria are to be found in [the author's book on] "The Nursing of Nervous Patients," Scientific Press, 1913.

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